Docket No. AJUTZ.0101

OPTICALLY ALIGNED CENTER PUNCH WITH INTEGRAL DOUBLE ACTION STRIKER

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit of the filing date of corresponding U.S. Provisional Patent Application No. 60/400,760, entitled "OPTICALLY ALIGNED CENTER PUNCH WITH INTEGRAL DOUBLE ACTION STRIKER," filed August 2, 2002.

BACKGROUND OF THE INVENTION

1. Technical Field:

The present invention is related generally to machinists' tools. More specifically, the present invention is directed toward an optically-aligned center punch with an automatic striker mechanism.

2. Description of Related Art:

Because standard, multi-flute twist drills are somewhat flexible and do not cut well at the end point, some means of starting a hole at a desired location is necessary to prevent the drill bit's drifting away from the intended placement. One method of starting holes is to place the point of a sharp object at the intended hole location and strike the object with a hammer to drive the point into the material leaving a small dimple at the intended hole location. A sharp object used for such a purpose is normally called a center punch.

Center punches of the style shown in **Figure 1** have existed for over one hundred years and are acceptable for low and medium precision work. The obtuse angle of the point limits the user's view of the point while aligning the punch to any desired location markings making accurate placement of the punch difficult. As shown in **Figure 1**, the angle of the punch relative to the work surface, the angle of the hammer face relative to the punch, and the angle of the tangent to the arc followed by the hammer at its point of impact with the punch relative to both the punch and the work surface all affect the motion of the punch into the work surface and, therefore, the placement accuracy of the final punch mark.

The alignment fixture shown in **Figure 2** alleviates some of the problems of the basic center punch by holding the punch perpendicular to the work. An optical sighting device the same diameter as the punch can be used to place the fixture with a relatively high degree of accuracy, but since the hammer is still wielded manually, the accuracy of the final punch mark is often no better than that which can be achieved without the fixture.

Adding a narrow shaft to the basic center punch allows the use of an annular weight as a slide hammer for striking the punch as shown in **Figure 3**. This arrangement ensures close alignment of the hammer's impact with the axis of the punch and, when used in conjunction with the alignment fixture of **Figure 2**, can be used to place punch marks with a relatively high degree of positional accuracy, but only on horizontal

surfaces. Devices which use smaller slide hammers driven by springs allow use on non-horizontal surfaces but require two hands to operate and are, therefore, difficult to use with an alignment fixture.

A more modern center punch with integral, double action striker is shown in **Figures 4A-4C**. This device (commonly called an "automatic center punch") requires only one hand to operate because pressing the body of the punch toward the work first compresses a spring against the striker and then releases the striker to impact the punch. This device addresses the two handed operation problem of the spring operated slide hammer punch but at the expense of some loss of accuracy due to the clearances required by the rocking motion of its latch mechanism.

Thus, a need exists for a center punch that allows for convenience of use in a variety of environments and applications, while maintaining a high level of accuracy.

SUMMARY OF THE INVENTION

The present invention is directed toward an automatic optical center punch adapted to perform with high accuracy and ease of use. The punch includes a spring-loaded hammer and a rotational latch mechanism. The rotational latch mechanism restrains the movement of the hammer to allow the spring to be compressed when pressure is initially applied to the punch by its operator. When the spring is fully compressed, the latch mechanism engages a cam surface, which causes the latch to rotate to release the hammer. The spring-loaded hammer makes contact with a punch head assembly, which causes perforation of the work surface to take place. Once the hammer has been extended by the spring, the latch engages a second cam surface, which causes the latch to rotate in the opposite direction to restrain the hammer in preparation for the next compression of the spring.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objectives and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

Figure 1 is a diagram of a prior art simple center punch;

Figure 2 is a diagram of a prior art center punch with an alignment fixture;

Figures 3A-3B are diagrams of a prior art center punch with gravity operated slide hammer striker;

Figures 4A-4C are cross-sectional diagrams of a prior art center punch with integral, double action striker in the three critical positions during use;

Figure 5 is a diagram of an alignment fixture in accordance with a preferred embodiment of the present invention;

Figure 6 is a diagram of an optical alignment sight in accordance with a preferred embodiment of the present invention;

Figure 6A is a diagram providing a close up of a spacer ring in **Figure 6**;

Figure 7 is a cross-sectional diagram of a center punch with integral, double action striker in accordance with a preferred embodiment of the present invention;

Figures 8-15 are diagrams of components of the punch shown in **Figure 7**;

Figures 16, 16A, 17-18, 18A, and 19 depict four phases of the operation of a punch striking mechanism in accordance with a preferred embodiment of the present invention;

Figures 20-22 depict, from the perspective of the user, the operation of a center punch made in accordance with a preferred embodiment of the present invention; and

Figures 23-24 depict an alternative embodiment of the present invention employing an alignment fixture with a concave surface for engaging work surfaces of various shapes.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention is directed toward an automatic optical center punch with a double-action striker mechanism for high precision one-handed creation of holes or indentation in the surface of a work piece.

USE

According to a preferred embodiment of the present invention, use of the optically aligned center punch is a two step process. As shown in **Figure 20**, the first step is to place optical alignment sight **200** within the bore of the alignment fixture **100** and align alignment fixture **100** with the desired reference point on work piece **2000.** Once alignment fixture **100** is properly positioned, it is held in place either manually or with clamps for the second step of the procedure.

During this process, a spacer ring **204** around reticle face **202** of the optical alignment sight **200** protects the reticle face from being scratched by small imperfections on the surface of the work piece while keeping the spacing between the reticle face consistent but small to minimize parallax errors during alignment.

Although the use of spacer ring **204** on optical alignment sight **200** increases the potential for parallax error when aligning alignment fixture **100** to the desired punch point, the narrow viewing range provided by the length of optical alignment sight **200** in relation to its

diameter makes the maximum parallax error a fraction of the spacing between the reticle face **202** and the work piece. In practice, the view through such an optical alignment sight makes it easy to align the viewing angle to within a few degrees of vertical and make the parallax error insignificant.

The second step of the procedure is to remove the optical alignment sight **200** from the alignment fixture **100**, place punch head **310** in the alignment fixture, and press end cap **370** of punch head **310** toward the work piece to actuate punch head **310**'s internal striker mechanism. This second step is shown progressively in **Figures 21** and **22**.

In an alternative embodiment of the present invention, depicted in **Figures 23** and **24**, a concave alignment fixture **400** is used in conjunction with optical alignment sight **200** to position concave alignment fixture **400** with respect to a location on a work surface that is not flat. In **Figures 23** and **24**, for example, cylindrical work surfaces **2300** and **2400** are shown. As shown in **Figures 23** and **24**, concave alignment fixture **400** allows placement on curved surfaces having a small radius of curvature relative to concave alignment fixture **400**, such as spherical work surface **2300**, or curved surfaces having a large radius of curvature relative to concave alignment fixture **400**, such as work surface **2400**. One of ordinary skill in the art will recognize that concave alignment fixture **400** may be used in conjunction with a wide variety of surfaces and that the application of concave alignment fixture **400** is by no means limited to spherical

work surfaces. Moreover, one of ordinary skill in the art will recognize that any of a wide variety of alignment fixture shapes may be utilized in conjunction with an automatic center punch in accordance with the present invention without departing from the scope and spirit of the present invention.

ALIGNMENT FIXTURE

Figure 5 shows a basic alignment fixture **100** for use on flat surfaces in conjunction with a center punch made in accordance with a preferred embodiment of the present invention. Alignment fixture **100** includes a bore **101** and work face **102**. Bore **101** should be large enough to admit a useful amount of ambient light, accurately finished within very close tolerance of its nominal diameter and straight. Work face **102** should be smooth and oriented to hold bore **101** in the desired alignment with the work piece when the fixture is held firmly against the work piece. For the illustrated fixture **100**, that means that the work face should be flat and perpendicular to the axis of the bore. Once these two critical features are ensured, the fixture should be shaped for easy manual manipulation and locating. Work face **102** may be covered or coated with an anti skid material to help hold it in place once it is properly located for use.

OPTICAL ALIGNMENT SIGHT

Figure 6 is a diagram of an optical alignment sight **200** in accordance with a preferred embodiment of the

present invention. Optical alignment sight **200** is used to position the alignment fixture **100** relative to the desired hole location on the work piece. Optical alignment sight **200** is made of an optically transparent material and is placed within bore **101** of alignment fixture **100** prior to use. Shaft **201** of optical alignment sight **200** should be straight and long enough to extend all the way through bore **101** of the alignment fixture **100** and sized to provide a close, but easily sliding cylindrical fit within bore **101**. Reticle face **202** of optical alignment sight **200** should be flat, perpendicular to the axis of shaft **201** and polished. Some form of visual alignment feature such as perpendicular lines intersecting at the alignment point ("cross hairs") should be scribed, etched or drawn on the reticle face **202**. A narrow, shallow recess **203** is formed around the periphery of reticle face **202** for the application of a thin spacer ring **204** which provides a small but definite space between reticle face **202** and the work piece. The relationship between the reticle face **202**, spacer ring recess **203** and spacer ring **204** is shown more clearly in the enlargement of one edge of the reticle face end of the sight shown in **Figure 6A**. The spacer ring **204** is preferably made of an abrasion resistant material and retained by an adhesive. Head **205** of optical alignment sight **200** has a non-critical diameter and should be long enough to protrude beyond the alignment fixture far enough for easy grasping for removal from the alignment fixture once the optical alignment is accomplished. Crown **206** of the sight is preferably radiused and

polished to provide some degree of optical magnification of the reticle face and the work piece.

CENTER PUNCH

A cross-section of a center punch **300** with integral, double action striker in accordance with a preferred embodiment of the present invention is shown in **Figure 7.** The device consists of a punch head **310**, an anvil **320**, a latch **340**, a latch spring **303**, a latch spring guide **380**, a cam sleeve **350**, a cam sleeve retaining clip **302**, a hammer **360**, a hammer spring **301**, a housing **330** and an end cap **370**.

Hammer spring **301** is a compression spring which fits around hammer **360** and within the cam sleeve **350**. Hammer spring **360**'s other parameters may be determined by normal spring design procedures to provide the striking energy desired.

Latch spring **303** fits around latch spring guide **380** and within bore **365** of hammer **360**. Latch spring **303**'s other parameters may be determined by normal spring design procedures to provide enough force to hold latch **340**, anvil **320**, and punch head **310** fully extended when center punch **300** is turned upside down.

Cam sleeve retaining clip **302** is an expanding, split, circular ring familiar to those skilled in the art and sized to fit securely in groove **337** in housing **330**.

CENTER PUNCH PIECES

Punch head **310**, which is shown in **Figure 8**, may be made from standard punch materials using techniques known to those skilled in the art. The body of punch head **310** should be straight, long enough to extend all the way through bore **101** of alignment fixture **100** (**Figure 5**) and sized to provide a close, but easily sliding cylindrical fit within bore **101** of alignment fixture **100**. Point **311** of punch head **310** should be concentric with the body of punch head **310**. The standard included angle (**312**) for center punches is 90° but other point designs could be made for special purposes. The end of punch head **310** opposite point **311** should be drilled and tapped **313** with a standard thread for attachment to anvil **320** (**Figure 9**), but punch head **310** and anvil **320** could be made as a single unit to reduce cost at the expense of easily interchangeable punches.

Anvil **320**, shown in **Figure 9**, is essentially an extension of punch head **310** and can be made of similar material using similar techniques. Shaft **322** of anvil **320** should have a close, easily sliding cylindrical fit in opening **333** at the bottom of housing **330** (**Figure 13**) while head **323** of anvil **320** should have a close, easily sliding cylindrical fit in cam sleeve **350** (**Figure 12**). Point **321** of anvil **320** is threaded to fit punch head **310** if the two are not made in one piece.

Latch **340**, shown in side view in **Figure 10** and in top view in **Figure 10A**, should be made of similar material to punch head **310** and anvil **320**. Latch base **341**

should have a close, easily sliding cylindrical fit in cam sleeve **350**, but with cam pins **342** evenly spaced around the perimeter (three are shown, but the actual number is not critical) which extend into cam slots **353** in cam sleeve **350**, but clear the inside of housing **330**. Shaft **343** should have a clearance fit within the smallest diameter of bore **365** of hammer **360**. Head **344** is splined for a close, easily sliding fit in splined bore **365** of hammer **360**. Spring retention stub **345** should protrude from head **344** at least the diameter of the wire used for latch spring **303**, but should have positive clearance from latch spring guide **380** when latch **340** is at the top of its stroke. Cam pins **342** and the tops of splines **344** should be hardened or coated with a hard substance and polished for easy sliding and long wear life.

Hammer **360** shown in side view in **Figure 11** and in top view in **Figure 11A** should be made of similar material to punch head **310**, anvil **320**, and latch **340**. Hammer base **361** should have a close, easily sliding cylindrical fit in cam sleeve **350**, but with guide pins **362** evenly spaced around the perimeter (three shown but the actual number is not critical) which extend into guide slots **358** in cam sleeve **350** but clear the inside of housing **330**. Hammer **360** has a bore **365** at the center down its length to clear latch shaft **343** and internally splined for a close, easily sliding fit with the splines on head **344** of latch **340**. The base is counter-bored (**363**) from the bottom for a close, easily sliding cylindrical fit around the outer diameter of head **344** of latch **340** to allow the splines in hammer **360** to disengage the splines on the latch with

head **344** of latch **340** still constrained within counter bore **363** of hammer **360**. Hammer body **364** should fit within hammer spring **301** and be as long as possible while leaving positive clearance between it and end cap **370** when hammer **360** is at the top of its stroke. Guide pins **362** and the bottoms of splines **365** should be hardened or coated with a hard substance and polished for easy sliding and long wear life.

Cam sleeve **350** shown in **Figure 12** is a tube with guide slots **358** for hammer **360** at one end and cam slots **353** for the latch at the other end. Inside bore **351** of cam sleeve **350** should be accurately finished within a very close tolerance of its nominal diameter, straight and parallel to the outside of the sleeve. The hammer end of the sleeve should be chamfered **352** on the inside to prevent snagging of hammer spring **301** on the edge. Cam slots **353** rotate latch **340** at each end of its travel to align and unalign latch head splines **344** with hammer bore splines **365**. The bottoms of cam slots **357** set the initial rotation of latch **340** to positively misalign latch head splines **344** from hammer bore splines **365**. Upper ends **354** of the misalignment portions of the cam slots slope to upper travel limits **355** of cam slots **353**, which are oriented to rotate latch head splines **344** into alignment with hammer bore splines **365**. The bottoms of the alignment portions **356** of cam slots **353** slope back to the bottoms of the cam slots to rotate latch head splines **344** back out of alignment with hammer bore splines **365**. Guide slots **358** are straight slots that prevent rotation of hammer **360** and limit its downward travel. The

entirety of cam sleeve **350** should be hardened or coated with a hard substance and polished for easy sliding and long wear life.

Housing **330** shown in **Figure 13** has an inside bore **331** within which cam sleeve **350** should have a close, easily sliding cylindrical fit. Lip **332** at the bottom of the housing retains both cam sleeve **350** and anvil **320** but is bored **333** for protrusion of the shaft **322** of anvil **320** (**Figure 9**). The outside of housing **334** is threaded **335** over part of its length for installation of end cap **370.** Threads **335** should extend over a long enough area to allow some adjustment of hammer spring **301** force by partially unthreading end cap **370.** Upper portion **336**of the outside of housing **330** should be relieved to slightly below the minor diameter of the threaded portion of housing **335** to provide clearance for the threads in end cap **372.** Groove **337** for cam sleeve retaining ring **302** should be positioned to allow cam sleeve retaining ring **302** to solidly locate cam sleeve **350** against lip **332** at the bottom of the housing.

Latch spring guide **380** shown in **Figure 14** is, in a preferred embodiment, simply a cylindrical pin sized to fit inside the latch spring and including some provision **381** for attaching it to end cap **370.** While the drawing shows screw threads for attachment provision **381,** a simple press or shrink type interference fitting would work as well. Free end **382** of latch spring guide **380** should be chamfered or radiused to prevent snagging on latch spring **303.**

End cap **370** shown in **Figure 15** has a section bored to clear threads **335** on housing **330** deep enough to cover housing threads **335** when end cap **370** is partially unscrewed for reduced hammer spring **301** tension. Adjacent to clearance bored section **371** is a section **372** threaded to match threaded section **335** of housing **330**. Adjacent to threaded section **372** of end cap **370** is a short section **373** bored to clear relieved upper section **336** of the housing and produce a shoulder **374** which provides a positive stop for threading end cap **370** onto the housing **330**. The profile of section **375** between shoulder **374** and hammer spring reaction surface **376** is not critical as long as it provides clearance for hammer spring **301** but the tapered section shown will ease assembly of the unit. The latch spring guide attachment provision **377** should match the attachment provision used on latch spring guide **381**.

PUNCH MECHANISM OPERATION

Figures 16-19 show center punch **300** with portions of cam sleeve **350**, hammer **360**, and latch **340** cut away in four different phases of the center punch **300**'s operating sequence. Latch spring **303** and latch spring guide **380**, although shown in **Figure 7**, are omitted from **Figures 17-19** for clarity.

In **Figure 16**, point **311** of center punch **300** is resting against the work with little or no pressure applied. Hammer spring **301** extends hammer **360** in the direction of point **311**. Hammer **360** is restrained from moving towards point **311** by hammer guide pins **362**, which

are at the bottoms of guide slots **358**. Latch spring **303** holds latch **340** at the bottom of its stroke against the anvil **320** and holds punch housing **330** and end cap **370** at their fully extended positions.

Figure 16A is an enlarged top view of hammer **360** and latch **340**, which shows their relative rotational positions in the phase of center punch **300**'s operation that is depicted in **Figure 16**. The portions of the splines on latch head **344** depicted with dashed lines are hidden from view due to their misalignment from the splines in hammer bore **365**.

As the user operates the punch by pressing punch housing **330** and end cap **370** toward the work piece, hammer spring **301** pushes hammer **360** toward latch **340** until the ends of the splines in hammer bore **365** meet the splines on latch head **344**. From that point, further depression of the punch body compresses hammer spring **301** between hammer **360** and end cap **370** until the tops of cam slots **353** reach cam pins **342** on latch **340**.

The point where the tops of cam slots **353** have reached cam pins **342** on latch **340** is depicted in **Figure 17**. At this point, the relative rotational positions of hammer **360** and latch **340** are still as shown in **Figure 16A**. However, since the tops of cam slots **353** in cam sleeve **350** are angled, further depression of the punch body causes the angled portions of cam slots **353** to apply a side force to cam pins **342** on latch **340** which, because latch **340** is confined within cam sleeve **350**, causes latch **340** to rotate. When the peaks of cam slots **353** have reached latch cam pins **342**, as shown in **Figure 18**, latch

340 has rotated enough to align the splines on latch head **344** with the splines in hammer bore **365** as shown in **Figure 18A**. At this point, hammer **360** becomes free to slide around latch head **344** and the energy stored in hammer spring **301** when it was compressed forces hammer **360** toward latch **340**. The base of hammer **360** impacts the base of latch **340** which, being in direct contact with the anvil, transfers the energy of the impact to anvil **320** which transfers it to punch **310**, driving the point of punch head **310** into the work piece.

As the user releases pressure on end cap **370** and housing **330**, latch spring **303** pushes end cap **370**, housing **330** and cam sleeve **350** away from the work. At the point shown in **Figure 19**, the splines on latch head **344** clear the splines in hammer bore **365** and the bottoms of cam slots **353** begin to apply a side force on latch cam pins **342** opposite to the side force applied when the punch body was pressed toward the work piece. This opposite side force rotates latch **340** back to its original position resetting the center punch for its next use.

Although the preceding description of the operation of the center punch refers to the rotation of the latch **340**, cam sleeve **350** does not have to be (and, in the embodiment described, is not) restrained from rotating. Thus, depending on relative friction between parts, cam sleeve **350** and hammer **360** could rotate instead of, or in addition to, latch **340**. The important motion in the operation of the center punch is the rotation of the latch relative to the hammer. Other possible designs could use a guide slot for latch **350** and a cam slot to

rotate hammer **360** or cam slots to rotate both latch **340** and hammer **360** in opposite directions.

The present invention provides a number of advantages over the prior art. When compared to the use of an alignment fixture, optical alignment sight and basic center punch with manually wielded hammer of prior art **Figure 2**, the constrained motion of the hammer in the preferred embodiment of the present invention described herein provides a consistent impact orientation that is difficult to achieve by hand. While the maximum achievable accuracy is no better, the range of error is much smaller.

The slide hammer punch in prior art **Figures 3A** and **3B** can be made to similar tolerances as the present invention for accuracy, but the present invention provides the ability to work on non horizontal surfaces as shown in **Figures 23** and **24**.

The rocking motion of the mechanism in the prior art center punch shown in **Figures 4A through 4C** requires much more clearance than the rotating mechanism of this invention and, therefore, cannot achieve the same level of consistency.

The description of the present invention has been presented for purposes of illustration and description, and is not intended to be exhaustive or limited to the invention in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art. The embodiment was chosen and described in order to best explain the principles of the invention, the practical application, and to enable others of

ordinary skill in the art to understand the invention for various embodiments with various modifications as are suited to the particular use contemplated.